STATE OF VERMONT

PUBLIC SERVICE BOARD

Joint Petition of Green Mountain Power Corporation, Vermont Electric Cooperative, Inc. and Vermont Electric Power Company, Inc. for a Certificate of Public Good pursuant to 30 V.S.A. § 248, to construct up to a 63 MW wind electric generation facility and associated facilities on Lowell Mountain in Lowell, Vermont and the installation or upgrade of approximately 16.9 miles of transmission line and associated substations in Lowell, Westfield and Jay, Vermont	)	Docket No. _____

PREFILED TESTIMONY OF

DAVID P. ESTEY, P.E.

ON BEHALF OF GREEN MOUNTAIN POWER CORPORATION

May 21, 2010

Summary of Testimony

Mr. Estey describes the proposed Kingdom Community Wind Project collector system and upgraded transmission and substation facilities. He also concludes that, assuming the System Impact Study confirms the determinations of the Draft Feasibility Study, the Project will not cause an undue adverse effect on transmission reliability or stability and, other than the facilities proposed to be built, no new transmission facilities are needed to serve the Project.

PREFILED TESTIMONY OF DAVID P. ESTEY, P.E.
ON BEHALF OF
GREEN MOUNTAIN POWER CORPORATION

1. Q. Please state your name, current position, employer and business address.

A. My name is David P. Estey. I am a Principal Electrical Engineer at RLC Engineering, LLC. My business address is 18 Meadow Road, Augusta, Maine 04330.

2. Q. Please state briefly your educational background and business experience.

A. I received my B.S. degree in Electrical Engineering from the University of New Hampshire in 1974. In 1980, I was awarded an M.S. degree in management by Thomas College.

I have thirty-five years of experience in the electric utility industry, including extensive experience in the areas of: Energy Management/Demand Side Management, rate and regulatory activities, electrical engineering, EMF and power quality activities, business development, and engineering consulting. Over the past five years I have been involved with the design of more than a dozen wind project electrical interconnections and have managed or participated in the construction of 4 wind farm power system interconnections. I have also been involved with power system impact analyses, providing technical support, interpreting results of simulations, and assisting with the compilation of numerous system steady state and stability studies. My resume is attached as **Exh. Pet.-DPE-1**.

3. Q. Have you ever testified before the Public Service Board ("Board") or in other judicial or administrative proceedings?

A. Yes. I have presented testimony to the Board in support of the Sheffield Wind Project (Docket 7156) and the Deerfield Wind Project (Docket 7250). I have also testified before the Maine Public Utilities Commission (MPUC) and the Federal Energy Regulatory Commission (FERC) on various tariff issues. I have presented testimony before the Massachusetts Facilities Siting Board on transmission line issues associated with various power plant projects including the Cape Wind Project. I have also presented similar testimony to the Connecticut Siting Council and the New York Public Service Commission.

4. Q. What is the purpose your testimony?

A. I describe the proposed electrical collector and transmission interconnection systems associated with the Kingdom Community Wind Project (the "Project") and how these systems will integrate with the Vermont Transco LLC ("VELCO") transmission system, and the sub-transmission and distribution systems of Vermont Electric Cooperative Inc. (VEC). These improvements are needed to deliver power from the wind farm to the VELCO transmission system.

I also provide testimony regarding the Project's compliance with Section 248 criteria relating to system stability, reliability and need for additional transmission facilities.

5. Q. Please summarize your conclusions.

A. Based on my review and assuming the System Impact Study (SIS) further reinforces the conclusions of the draft Feasibility Study (FS), the Project will not cause an undue adverse effect on transmission reliability or stability and, other than proposed Project facilities, no new additional transmission facilities will be needed to serve the Project.

6. Q. Please begin with an overview of the Project's electrical system.

A. In order to interconnect the wind generation facility to the utility transmission system, certain facilities must be constructed. These facilities include: (1) medium voltage collector circuits to funnel the wind turbine generation to a single point of delivery, (2) a collector substation to aggregate the wind turbine generators output and step up voltage from 34 kV to 46 kV, and (3) upgrades to the existing transmission system to transport the output to the VELCO 115 kV system. The medium voltage collector circuits consist of a combination of 34.5 kV aerial and underground facilities that connect the wind turbines with the collector substation. The collector substation, which is located approximately midway between the ridgeline and Route 100, transforms the wind farm generator output from a 34.5kV to 46kV in order to more efficiently transmit the power to points of delivery. From the collector substation, the wind generator output is transmitted via a 46 kV transmission line to be constructed along Vermont Route 100 to the new Vermont Electric Cooperative, Inc. ("VEC") Lowell # 5 Substation located in Lowell approximately 2.5 miles north of the intersection of the Project access road and Route 100. The Lowell #5 substation will replace both the existing VEC Lowell substation and the adjacent VEC Irasburg #21 substation. A portion of the existing Lowell substation provides a tie

connection to the Central Vermont Public Service Corporation ("CVPS") Lowell Substation. This connection will be preserved as part of the Project.

The existing 10.4-mile VEC 34.5 kV transmission line between the existing Lowell Substation and the Jay #17 Substation will also be upgraded from 34.5 kV to 46 kV. The Jay #17 substation will also be upgraded to 46 kV. The two-mile distribution line between the Jay 17 substation and the intersection of Cross Road and Route 105, where it interconnects with the VELCO 46 kV line, will be upgraded to 46 kV. The two-mile segment of VELCO line between this location and the proposed VEC Jay Tap switching station will be reconductored.

A plan and profile identifying the locations of proposed transmission upgrades is attached as **Exh. Pet.-DPE-2**. An orthophoto showing the proposed locations of the transmission upgrades is attached as **Exh. Pet.-DPE-3**. A system one-line diagram illustrating how the Project and the associated upgraded facilities will connect to the VELCO 115 kv system is attached as **Exh. Pet-DPE-4.**

7. Q. Please describe the Project's collection system.

A. The collection system consists of two principal components: the collector circuits and the collector substation. See **Exh. Pet.-DPE--5-6**. Green Mountain Power Corporation ("GMP") will construct two 34.5 kV collector circuits connecting 20 or 21 wind turbines. The collector circuit segment in the area of the turbines will consist of 34.5 kV underground cabling with conductors ranging in size from 1/0 AWG aluminum conductor to 750 kcmil aluminum

conductor. There are four underground cable circuits, which will each interconnect 4 to 6 turbines to two aerial trunk line circuits. The cables will connect to a 34.5 kV SF6 gas circuit breaker, a protection device, located inside the base tower section of each wind turbine. The underground cable system will transition to two 795 kcmil ACSR (aluminum conductor steel reinforced) aerial trunk circuits as shown on the exhibits sponsored by Mr. Jewkes. These overhead pole lines will connect the last turbine on each underground circuit to the collector substation located on the project access road as shown on **Exh. Pet.-DPE-6**. The overhead segment of the collector system will consist of wooden mono-pole and H-frame structures ranging in height from 43 feet to 52 feet above ground. GMP will install 72 pair, ADSS fiber optic cable on the poles to facilitate Project communication, data acquisition and control. The plan, profile, pole heights and locations of the aerial collector system circuits are depicted in **Exh. Pet.-DPE-6**. Typical structure configurations are also illustrated on **Exh. Pet.-DPE-6**.

8. Q. Please describe the collection substation.

A. The collector substation will serve as the single collector point or aggregator of the electricity generated by wind turbines. At this collection point, the generation is stepped from 34.5 kV to 46 kV in order to more efficiently transmit the power to the VELCO transmission system. The collector substation will largely consist of steel structures, transformers and protective equipment on concrete footings located within a 140 foot by 140 foot cleared and fenced area. The tallest collector substation elements are projected to be approximately 45 feet above grade level. Details of the collector substation are provided on

Exh. Pet.-DPE-7. An orthophoto of the proposed collector substation is shown inn **Exh. Pet.-DPE-8**.

The substation will include the following components:

- Three 34.kV5 kV circuit breakers
- One kV46 kV circuit breaker
- 34.5kV & 46kV switches and disconnects
- One 34.5kV x 46kV, 66.7MVA grounded wye – delta transformer
- Two 34.5 kV x 480 V, 2 MVA padmount transformers – grounding banks
- Insulators, aluminum bus tube and steel bus support structures
- 4MVAR dynamic var compensator and associated 4 MVA transformer
- 46 kV steel deadend structure
- 46 kV surge arrestors and voltage transformers
- Three bay 34.5 kV steel bus structure
- 34.5 kV surge arrestors and voltage transformers
- Control building with 125 Volt DC battery, control panels and relaying

GMP will install the collector substation transformer on a concrete slab with a lined gravel moat for oil containment around the perimeter of the concrete slab. A secondary oil containment system will consist of a gravel over fabric berm (approximately 12 inches in height) around the perimeter of the substation. Plans for the transformer oil containment system, along with the control building, are shown on **Exh. Pet.-DPE-7.** There will be perimeter fence lighting on a switched circuit to facilitate night-time maintenance work. Details on the substation lighting are provided in **Exh. Pet.-DPE-9**.

9. Q. Please describe the KCW generator exit line.

A. The generator exit line connecting the collector substation and the VEC Lowell # 5 substation will consist of new 46 kV transmission wire on cross arm construction, extending west Vermont Route 100, and then northward along Route 100 to the new VEC Lowell #5 substation. The poles will range in height from 35 feet to 52 feet above ground. Along Route 100, Petitioners will relocate the existing VEC distribution line to the new poles and remove the old distribution poles. In addition to the existing facilities, the transmission line has been designed to allow for future communications attachments points and future single or three-phase distribution upgrades. This section of the collector system is shown on the plan and profile, **Exh. Pet.-DPE-2**, sheet numbers 4-9.

10. Q. Please describe the new Lowell #5 substation.

A. The new Lowell #5 Substation will be located within the footprint of the existing VEC Irasburg #21 substation (located immediately north of the existing VEC Lowell #5 substation). The new VEC Lowell #5 substation will step down voltage from 46 kV to 12.47 kV to serve VEC distribution customers, presently being served by the existing Lowell # 5 substation. The footprint of the new VEC Lowell #5 substation will be the same as the current Irasburg #21 substation with a 140-foot by 140-foot fence perimeter. The tallest components will increase from approximately 24 feet to approximately 36 feet. The layouts of the existing and proposed substations are set out on **Exh. Pet.-DPE-10, 11**.

The Lowell #5 Substation will consist of the following components:

- Three (3) – 46kV circuit breakers
- KCW Revenue Metering with associated Potential Transformers (PT) and Current Transformers (CT)
- One (1) 7.5/9.3 MVA, 46kV x 12.47kV substation transformer
- Three (3) 7200V step voltage regulators
- Two (2) 15kV distribution reclosers
- Various switches, steel bus support structures, disconnects, arresters, fuses, steel, copper tubular bus, lighting and insulators with associated foundations, conduit and cabling
- Control building with protective relaying, SCADA and communications.

The VEC Lowell #5 substation general arrangement design and one line is shown in **Exh. Pet.-DPE-11.** An orthophoto for this proposed substation is shown in **Exh. Pet.-DPE-12**.

The new VEC Lowell #5 substation will include perimeter fence lighting as shown on **Exh. Pet.-DPE-9**. There will be one light on the gate entrance to the substation, which will switch on at night automatically.

The proposed oil containment system at the new Lowell #5 substation will consist of a concrete moat around the transformer and a berm around the perimeter of the yard. See **Exh. Pet.-DPE-11**, drawing C2-1**.**

The new Lowell #5 substation will also be connected to the CVPS 46kV system through a SCADA-controlled motor-operated tie switch and a circuit breaker. The tie will normally be left

open, but can be closed to provide feeder back-up to restore power to the VEC customers, in the event of an outage on the 46 kV line north of the new VEC Lowell #5 substation.

The current Lowell #5 substation contains components owned by CVPS and elements owned by VEC, which are physically separated by a fence. After VEC constructs the new Lowell # 5 substation, it will decommission its portion of the existing Lowell #5 Substation and the remaining elements will be owned solely by CVPS.

The VEC Lowell #5 Substation will be the revenue metering location for sales of Project electricity to VEC. As required by ISO-NE metering requirements, the metering will be compensated for losses from the Lowell Substation up to the VELCO 115kV system.

11. Q. Please describe the decommissioning plans for the current VEC Lowell #5 Substation and the Irasburg #21 substation.

A. The load currently served by the Irasburg #21 substation will be transferred to the new Lowell #5 substation. The existing VEC Lowell #5 and Irasburg #21 substations will be decommissioned at the end of Project construction in accordance with good utility practices. Decommissioning will include removal and disposal of all of the existing structures, foundations and equipment, any necessary remediation of the area and the addition of top soil and reseeding, all in accordance with a reclamation report to be filed with the Board.

12. Q. Please describe the upgrades between the new Lowell # 5 substation and the VEC Jay #17 substation.

A. Petitioners will upgrade the 10.4 mile VEC 34.5 kV line between Lowell and Jay from 34.5 kV to a 46 kV, 795 kcmil ACSR conductor and a protection system upgrade to include 46kV breakers and protective relaying equipment at each terminal. The rebuilt 46 kV line will be largely in the same location as the current 34.5 kV line. In several sections, Petitioners will relocate the line closer to the adjacent highway, to allow for easier construction and maintenance, or to address right-of-way infringements from existing structures. The upgraded transmission line will be built in a single-pole configuration similar to the existing 34.5 kV transmission line (open wire on cross arms with distribution underbuild and communications facilities). The new line will also provide space to allow for future distribution upgrades and communications attachments. Where feasible, existing easements will be increased to 100 feet in width. The present above grade pole heights, which range from 27 feet to 52 feet, will increase generally to a range of 43 feet to 52 feet, with one pole extending 58 feet above grade located near Carmel Road off of Route 100 in Westfield, Vermont. Details of this upgrade segment are contained in **Exh. Pet.-DPE-2**.

13. Q. Please describe the improvements to the VEC Jay #17 Substation.

A. Petitioners will rebuild the Jay #17 substation within its existing footprint The tallest components will increase from approximately 24 feet to approximately 45 feet in height. Details of the Jay #17 substation rebuild are contained in **Exh. Pet.-DPE-13.**

The new VEC Jay #17 substation will consist of the following components:

- One 7.5/9.3 MVA, 46kV x 12.47kV substation transformer
- Three 7200V voltage step regulators
- Revenue class primary metering with associated CT's and PT's
- Four 15kV distribution reclosers, one for future use
- Various switches, disconnects, arresters, fuses, steel bus support structures, copper tubular bus, lighting and insulators with associated concrete foundations, conduit and cabling

Unlike the new Lowell #5 substation, the new Jay #17 substation will not have a control building, or transmission circuit breakers. The new Jay #17 substation will be fed by the 46kV system with motor operated, SCADA-controlled, load break switches at each of the two connection points. In the event there is an outage on the 46kV line, these switches can be used to isolate sections of the line and restore power quickly to VEC customers. The new Jay #17 substation will have the same type of oil containment system as the new VEC Lowell # 5 substation. The lighting will be similar to the new Lowell # 5 substation lighting. See **Exh. Pet-DPE-9.** An orthophoto of this proposed substation is shown on **Exh. Pet.-DPE-14**.

14. Q. Please describe the upgraded facilities between the VEC Jay #17 substation and the VELCO Jay Tap Substation.

A. The two-mile VEC distribution line segment between the Jay 17 substation and the VELCO 46 kV line at the intersection of Cross Road and Route 105 will be upgraded to 46 kV. The rebuilt line will be largely in the same location as the current line. In several sections, the line will be relocated closer to the adjacent highway, to allow for easier construction and maintenance. The new pole line will be built in a single-pole configuration similar to the

existing line, will consist of open wire 795 kcmil ACSR conductor on cross arms with distribution underbuild and communications facilities, and will provide space to allow for future distribution upgrades and communications attachments. The current pole heights range from approximately 35 feet to 52 feet and will be increased to approximately 43 feet to 61 feet. Where feasible, the existing easements will be increased to 100 feet in width. Details of this portion of the upgrade are contained in **Exh. Pet.-DPE-2**.

Petitioners will install three new switches capable of being motor-operated and SCADA controlled at the intersection with the VELCO 46 kV line. Details are shown on **Exh. Pet.-DPE-15** and **Exh. Pet.-DPE-16**. From the new switching structure, the existing VELCO 46 kV line will be reconductored to 795 kcmil ACSR on the existing structures for approximately 2 miles west to the 46 kV line terminal at the proposed VEC Jay Tap Switching Station. (The proposed switching station is being reviewed separately in Docket No. 7604). The reconductoring work is further described on **Exh. Pet.-DPE-17**.

VELCO will construct a new VELCO Jay Tap Substation immediately adjacent to the VEC Jay Tap Switching Station, which will interconnect the 46 kV line with the VELCO 115 kV transmission line system, which runs between Highgate and Newport. The proposed substation, is currently under design and will be reviewed in a separate proceeding.

The transformers used in the proposed substation upgrades will contain non toxic mineral oil as an insulating medium. Medium and high voltage circuit breakers will employ gas or vacuum

insulation to minimize the use of insulating oils. All Project procurement specifications and construction contracts will require materials suppliers and contractors to comply with all applicable health and environmental regulations regarding disposal of wastes.

15. Q. Who designed the substations and transmission line proposed by Petitioners?

A. RLC Engineering, LLC developed conceptual designs of the upgraded VEC Lowell #5 and Jay # 17 substations and the collector substation. SGC Engineering designed the transmission system upgrades between the collector substation and the 46kV intersection at Route 105 and Cross Road in Jay. VELCO and Ulteig Engineers Inc. designed the VELCO 46 kV line reconductoring and the switching structure at the 46 kV interconnection. VEC and GMP engineering operation staff have reviewed these designs. CVPS will also review facilities designs that connect with CVPS, such as the new Lowell #5 Substation.

16. Q. Have Petitioners considered any alternative interconnection options?

A. Yes. Petitioners have considered the alternative of interconnecting at CVPS's Lowell Substation. This substation is fed from a 46 kV line running from the VELCO Irasburg substation and steps down 46 kV to 34.5 kV by means of a 15/20 MVA autotransformer. From the CVPS Lowell substation, power flows south to the CVPS Johnson Substation and north to the VEC Jay #17 Substation through the 34.5 kV sub-transmission system. The CVPS Lowell substation is also a 34.5 kV power source for the existing VEC Lowell #5 substation, which steps the voltage down to 12.47 kV and feeds local VEC distribution customers.

17. Q. Why is that option not being proposed?

A. The CVPS Lowell interconnection involved significantly more transmission line and substation upgrades and would cost more than the proposed upgrade. Based on a previous feasibility study performed by CVPS, which considered a smaller Project totaling 42MW, a 63 MW Project would have required the following system upgrades:

1. Rebuild 12 miles of 46 kV transmission line between Lowell and Irasburg;
2. Rebuild and upgrade to 46 kV, 18 miles of 34.5 kV transmission line between Lowell and Johnson;
3. Expand the CVPS Lowell substation to accommodate the wind farm interconnection and the upgraded line to Johnson;
4. Rebuild and upgrade the CVPS Johnson and North Hyde Park Substations to accommodate increase in voltage from 34.5 kV to 46 kV;
5. Rebuild and upgrade the Vermont Asbestos Substation to accommodate an increase in voltage from 34.5 kV to 46 kV.

This alternative would have required twice the amount of transmission facility upgrades and three times the amount substation facility upgrades necessary to accommodate the Project.

18. Q. Please describe the efforts to identify the Project's impact on system stability and reliability.

A. ISO-New England recently completed its draft of an Interconnection Feasibility Study on the KCW Project. The draft, which is awaiting comment from affected utilities, is attached as **Exh. Pet.-DPE-18**. The feasibility study examines and measures the effects of the proposed Project on the medium and high voltage transmission systems in Vermont and neighboring New Hampshire. The feasibility study models the transmission system with and

without the Project in service and identifies the impact of the Project. In particular, the study evaluates changes in voltage, thermal loading on the transmission line conductors and substation transformers, Project contributions to fault duty, and impacts that result when transmission lines and transformers are taken out of service.

The feasibility study concludes that at certain load criteria and Project output, there will be adverse impacts to the voltage on the 46kV system at various parts. For example, the study identifies necessary improvements to the system to bring the 46kV voltage back into acceptable limits during system contingencies, when the Project is at full output. These additions are as follows:

- Add 4MVAR dynamic reactive support at the collector substation on the 34.5kV.
- Adjust the transformer tap at the collector substation to a voltage ratio of 1.025.
- Increase the four proposed capacitor banks at the proposed VEC Jay Switching station from 2.7MVAR to 5.4MVAR for a total increase to the system of 10.8MVAR.
- Adjust the VELCO Jay Tap substation transformer tap to a voltage ratio of 0.975.
- Add a 5.4MVAR cap at the Newport-B2 bus for area voltage support.

Out of the five items listed above, only the increased capacitors at the VEC Jay switching station, and the Newport capacitors, require additional work to the transmission system. The remaining items are either already planned, or are simple changes. It should also be noted that GMP continues to address other methods to resolve the voltage criteria violations, which are described

in the feasibility study. A final conclusion on these alternatives will not be made until after review of the SIS, which is expected to be completed this summer.

The Project will comply with all applicable regulations regarding the disposal of construction waste. The Project will not involve the injection of waste materials or any harmful or toxic substances into ground water or wells. None of the proposed electrical systems (collector system of substations) will produce any waste material or emit toxic or harmful substances into ground water or wells.

19. Q. Please summarize your preliminary assessment of the Project's compliance with the system stability criterion of 30 V.S.A § 248?

A. Based on the above review and subject to the SIS, I conclude that the Project should not adversely affect system stability and reliability. This conclusion is contingent on the completion of the SIS. The previously-described improvements will be sufficient to transmit the Project output to the VELCO 115 system in a reliable manner.

20. Q. Can the Project be served economically by existing or planned transmission facilities as required by 30 V.S.A. 248(b)(10)?

A. Yes. The Project can be served economically by existing or planned transmission facilities without undue adverse effect on Vermont utilities or customers. The previously-described improvements will be sufficient to transmit the Project output to the VELCO 115 system in a reliable manner.

21. Q. Does this conclude your testimony?

A. Yes.